Project Report

Date	**17th November**
Team ID	**PNT2022TMID21469**
Project Name	**Smart waste management system for metropolitan cities**

SMART WASTE MANAGEMENT FOR METROPOLITAN CITIES

1. INTRODUCTION

1.1 Project Overview:

This Project consists of two sub-projects; a mobile Application and IoT enabled bins.The IoT enabled bins provide real time inputs to the mobile Application that serves an interface to handle the waste management practices effectively and efficiently.The mobile Application also contains many added functionalities like, locating the next nearest dustbins (and many other public facilities like restrooms, public taps), grievance redressal functions, chatbots to educate the people on proper waste disposal procedures.These two functionalities work together concurrently as an integrated entity.

1.2 Purpose:

This project aims to control the proper disposal of urban waste, which is the main cause of ill health among the citizens.This project covers other public facilities such as public water and restrooms, and deals with their management.

This project elevates the lifestyle of the citizens and focuses primarily on waste management and disposal from the perspective of an urban community.Is the level and quality of the solid waste handling and disposal practices and the common public facilities in India at par with the recommended standards as per the UN convention?

2. LITERATURE SURVEY:

2.1 Existing problem:

1. SENSONEO- Smart waste app for every city

- See all the bins on the map.
- Find the nearest available bin.
- See how full the bin is.
- Find the right bin for your waste type – general, glass, plastic, etc.
- Discover the shortest route to the bin.
- Take a picture and report any problem with the bin.
- 119 Euros - cost

Inference:It is an Android app which provides solutions by partnering with cities.

2. SWACHH DELHI:

- App for enhanced waste and civil bodies management.
- Free of cost

Inference: It has a lot of issues.

3. Central Government's IWMS (INTEGRATED WASTE MANAGEMENT SYSTEM):
- This website tracks civil bodies that produce waste.
- The portal will also facilitate the people in obtaining permission for import and export of certain categories of waste, for reuse, recycling, recovery or co-processing and conserve the primary source.
- free of cost

Inference: It is still in a development stage. Only the beta release is out yet.

2.2 References:

1. E. Y. Prisyach and O. A. Shvetsova, "Elements of Innovative Scenario's Development of Waste Management System in Russia," 2018 IEEE International Conference"Management of Municipal Waste as an Important Factor of Sustainable Urban Development" (WASTE), St. Petersburg, 2018, pp. 63-65, doi: 10.1109/WASTE.2018.8554154.

2. P. Ravindhiran, P. Gopal, S. J. Gladwin and R. Rajavel, "Automated indoor waste management system employing wavefront algorithm and received signal strength indicator values-based mobile robot," 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), Dhaka, 2017, pp. 284-289, doi: 10.1109/R10-HTC.2017.8288958.

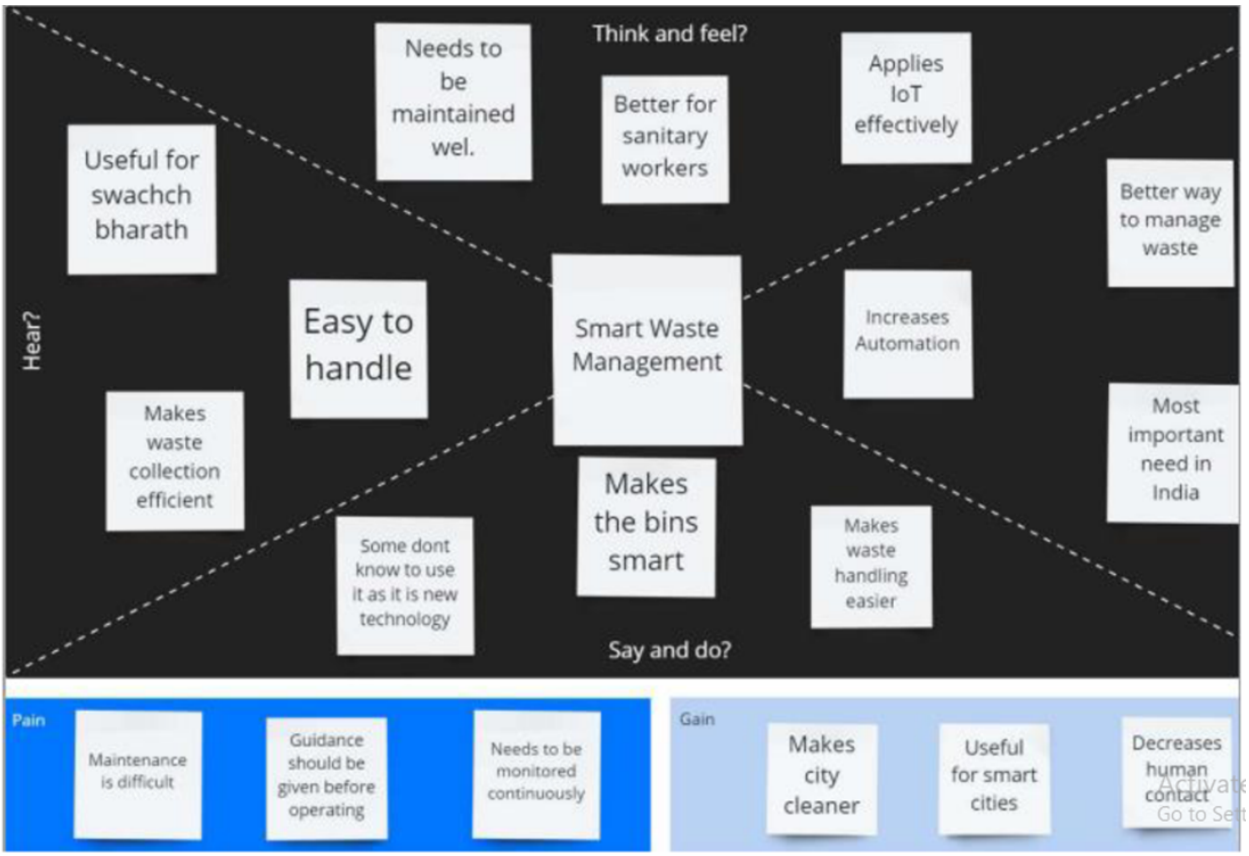
3. E. Y. Prisyach and O. A. Shvetsova, "Elements of Innovative Scenario's Development of Waste Management System in Russia," 2018 IEEE International Conference"Management of Municipal Waste as an Important Factor of Sustainable Urban Development" (WASTE), St. Petersburg, 2018, pp. 63-65, doi: 10.1109/WASTE.2018.8554154.

2.3 Problem Statement Definition:
The Indian Municipalities are not at par with the global standards for collecting urban waste effectively and efficiently. There is a need for a smart and innovative approach to ensure 100% waste collection in a hygienic manner.

Objective:
We have implemented an intelligent solution that improves the waste management process using IoT devices with an Android application.

3. IDEATION & PROPOSED SOLUTION:

3.1 Empathy Map Canvas:



3.2 Ideation & Brainstorming:

917719IT005

Integrated system

IOT Technology

Gsm module, to send data as SMS

IBM Cloud platform

Different mobile interface for different stakeholders

917719IT081

Smart bins with Arduino

Python flask to develop API

Firebase as cloud database

MongoDB as a database

ultrasonic senor, to measure the bin level

917719IT092

Mobile application which integrates all the bins

ML server to predict future level of bin

database or cloud database to store mobile application data

on premises database

android studio for app development

917719IT111

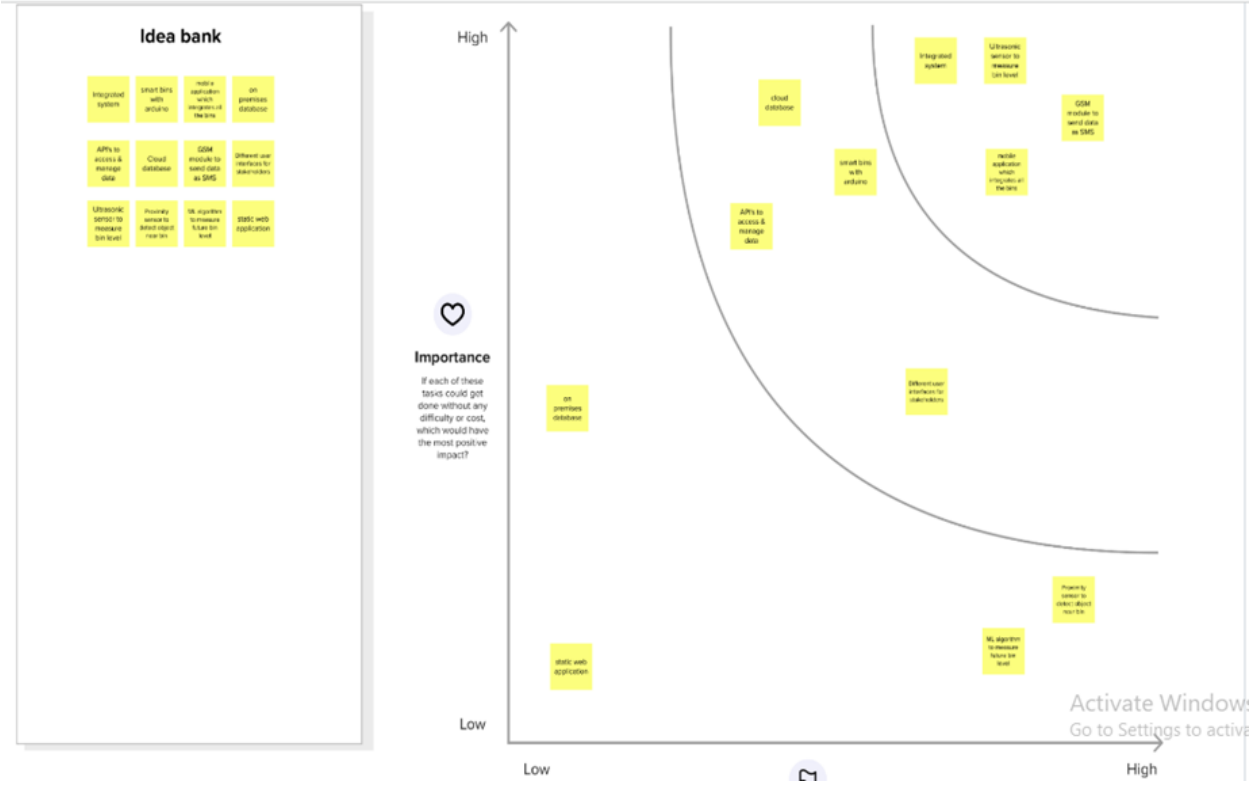
Cloud storage to store the data from the bin

API's to manage & access data from cloud

proximity sensor to detect object near bin

cloud database

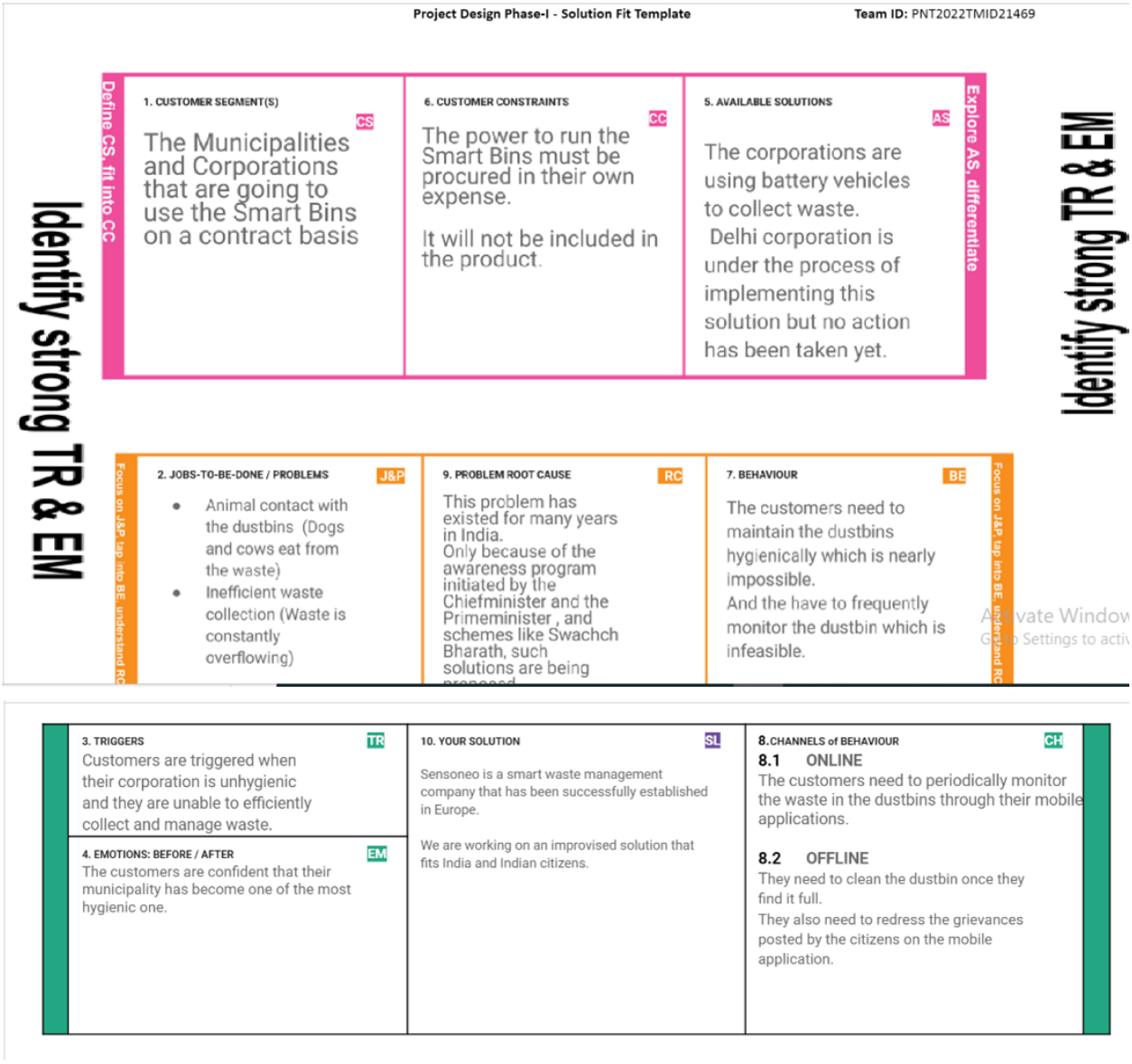
Simple static web application



3.3 Proposed Solution:

S.No.	Parameter	Description
1.	Problem Statement (Problem to be solved)	Smart Waste management system for metropolitan cities To create a hygienic environment in metropolitan cities and to enable efficient waste collection and management.
2.	Idea / Solution description	To create an integrated application using IoT and mobile application so that the level for the waste can be monitored in real-time.
3.	Novelty / Uniqueness	The Ultrasonic sensor that is embedded inside the dustbin can produce ultrasound which can repel the animals, hence preventing animal contact.
4.	Social Impact / Customer Satisfaction	This is an initiative towards the Swachch Bharath scheme to make the metropolitan cities more hygienic and environment friendly.
5.	Business Model (Revenue Model)	**Product** : SmartBins **Potential Clients** : Municipalities and corporations **Services** : Maintenance of the SmartBins The SmartBins are rented to the corporations and municipalities on a contract basis. Maintenance and other services will be charged accordingly.
6.	Scalability of the Solution	The solution contains a Server to store all incoming data from the IoT enabled SmartBins. This is stored in a centralised Database and processed. The mobile Application fetches all the data from the server. Hence Scalability is achieved through centralisation.

3.4 Proposed Solution Fit:



4.REQUIREMENT ANALYSIS:

4.1 Functional Requirement :

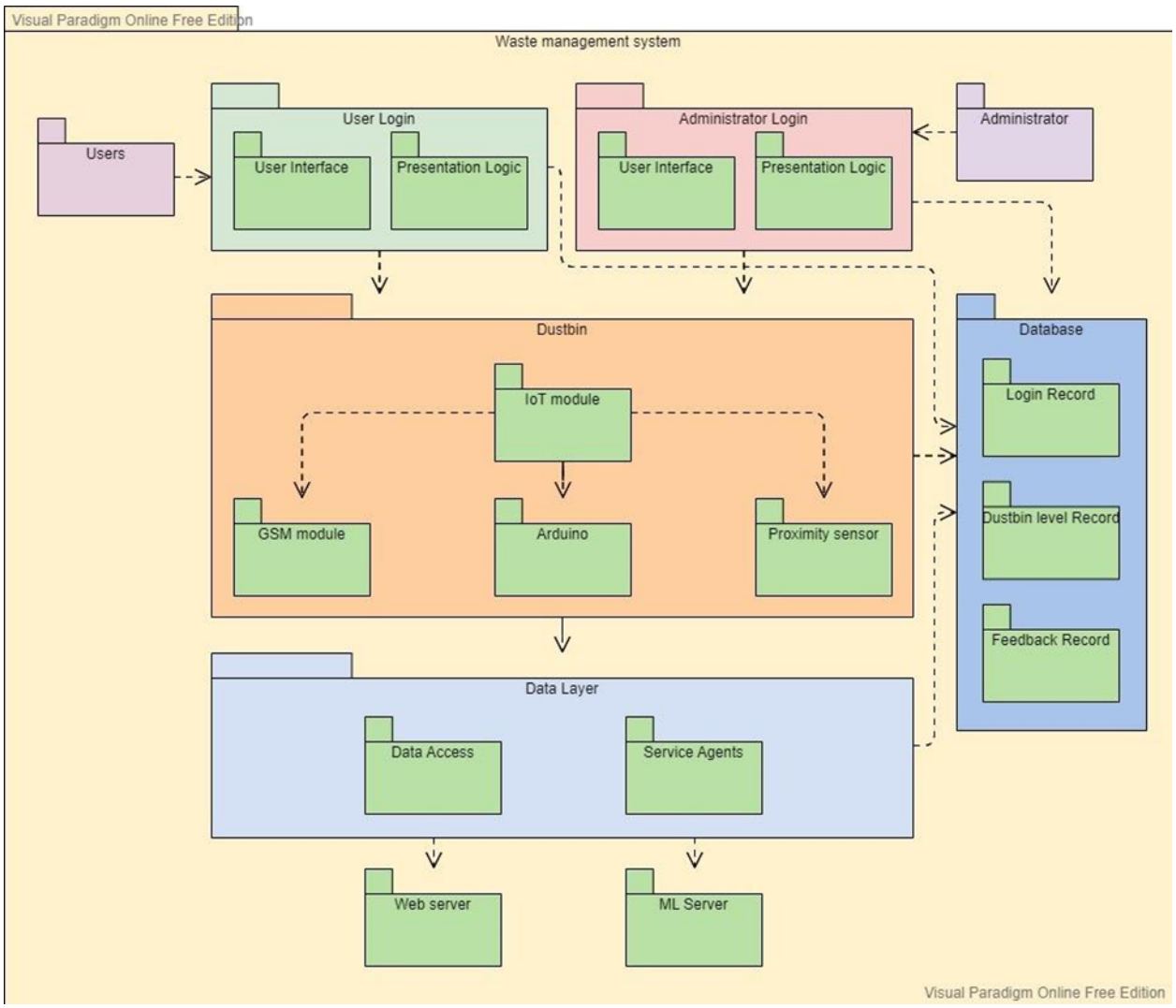
1.Register/login:it shall provide a robust login page.
2.Alert message:sends an alert message to workers when bins are full.
3.Locations:it shall locate nearby bins,toilets etc..,
4.Share locations:Enables to share locations with others.
5.Feedback:It helps the developer side to improve apps by further releases.
6.Forums:It shall include forums to post the problems.

4.2 Non-Functional requirements:

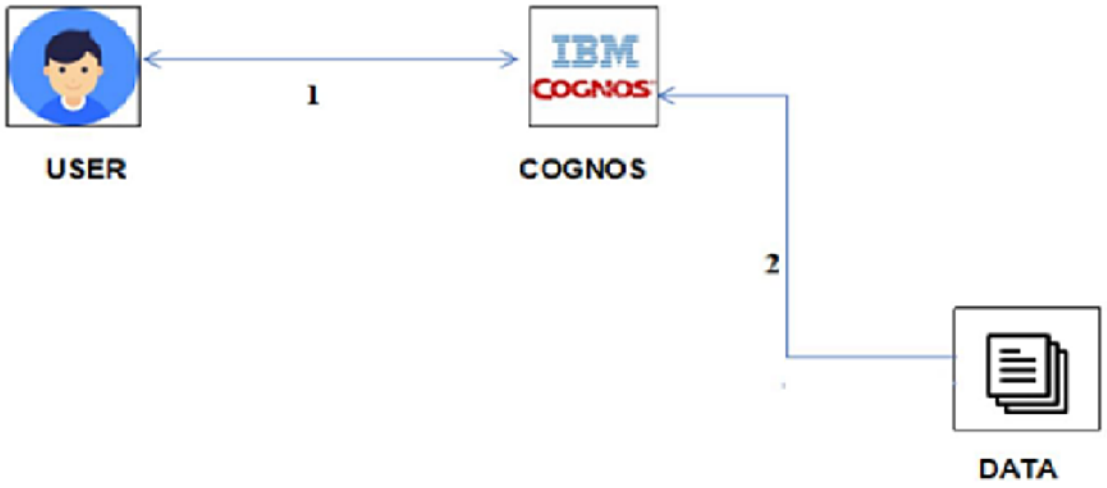
1.Security:Provide security for user data.
2.Performance:It provides excellent experience.
3.Usability:Interactive with rich UI and chatbot.
4.Accessibility: Available all through the day.
5.Compatibility:Available for android,iOS
6.Scalability:The integrated DBMS shall handle a rising number of residents.

5. PROJECT DESIGN:

5.1data flow diagram:



5.2 Solution & Technical Architecture:



5.3 User Stories:

User Stories

Use the below template to list all the user stories for the product.

User Type	Functional Requirement (Epic)	User Story Number	User Story / Task	Acceptance criteria	Priority	Release
Customer (Mobile user and Laptop users)	Registration	USN-1	As a user, I can register for the application by entering my email, password, and confirming my password.	I can access my account / dashboard	High	Sprint-1
		USN-2	As a user, I will receive confirmation email once I have registered for the application	I can receive confirmation email & click confirm	High	Sprint-1
		USN-3	As a user, I can register for the application through Facebook	I can register & access the dashboard with Facebook Login	Low	Sprint-2
		USN-4	As a user, I can register for the application through Gmail		Medium	Sprint-1
	Login	USN-5	As a user, I can log into the application by entering email & password		High	Sprint-1
	Dashboard	USN-6	Can use the methods provided in the dashboard		Medium	Sprint-1
	Invest	USN-7	With help of desired results obtained from application ,making profit or loss	Gain or Loss	High	Sprint-2
Administrator	Updating data		Collecting the data and storing it	Checking and updating dataset	High	Sprint-1
Customer (Web User)	Accessing the resources	USN -8	Using my own credentials for accessing the data	These resources cannot be accessed by others but only me	High	Sprint -1
	Satellite Visioning	USN -9	Having a view with geographic data		Medium	Sprint-2
Customer tools	Tools	USN -10	Analysis is performed by tools like cognos analytics	Ease of accessing the tools	High	Sprint 2

6. PROJECT PLANNING & SCHEDULING:

6.1 Sprint planning and estimation:

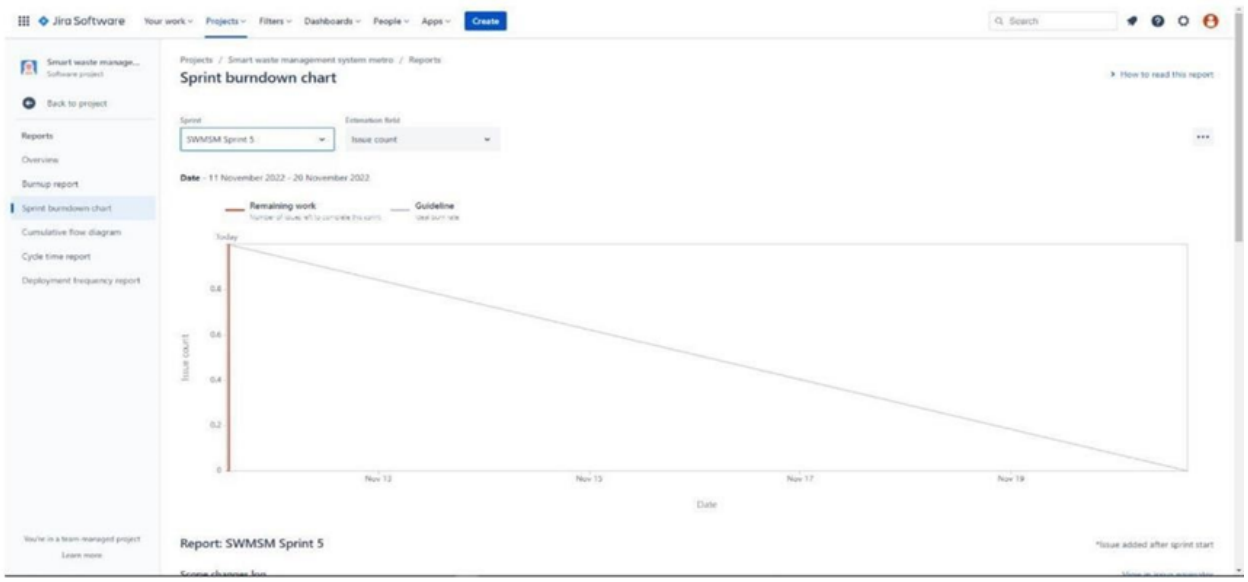
Sprint	Functional Requirement (Epic)	User Story Number	User Story / Task	Story Points	Priority	Team Members
Sprint-1	Registration	USN-1	As a user, I can register for the application by entering my employee ID, email, password, and confirming my password.	1	High	Shyam, Ajay Rajan
Sprint-1	Confirmation	USN-2	As a user, I will receive confirmation email once I have registered for the application	1	Medium	Shyam
Sprint-1	Login	USN-3	As a user, I can log into the application by entering email & password	2	High	Shyam
Sprint-1	Dashboard	USN-4	As a user, I can access all resources in the dashboard.	2	Medium	Tamilselvan
Sprint-1	Monitoring	USN-5	As a user, I can monitor the status of the smart bins.	1	High	Tamilselvan
Sprint-2	Cloud configure	USN-6	Create and configure the IBM Cloud services which are being used in this project.	2	High	Sajeev Krishna
Sprint-2		USN-7	Connect the IoT device to the IBM cloud, create a device in the IBM Watson IoT platform and get the device credentials.	3	Medium	Sajeev Krishna
Sprint-2		USN-8	Develop a python script to publish random sensor data such as Loadcell, IR sensor and GSM/GPS to the IBM IoT platform	4	Medium	Shyam, Tamilselvan
Sprint-3	Creates and maintains	USN-9	As an admin, I can create and maintain all information about the bins.	2	Medium	Tamilselvan, Ajay
Sprint-3	Provide credentials	USN-10	As an admin, I can provide or revoke login credentials to the municipality employees	1	Low	Ajay Rajan, sajeev. Shyam
Sprint-4	Alerting	USN-11	As a user, I can alert the truck drivers to clear trash by sending the location of bin as SMS.	3	High	Ajay Rajan. Tamilselvan
Sprint-4	Add/Remove/Update smart bins in a locality	USN-12	As an admin, I can add, remove or update any bins in that locality into the system.	2	Medium	Shyam, Sajeev

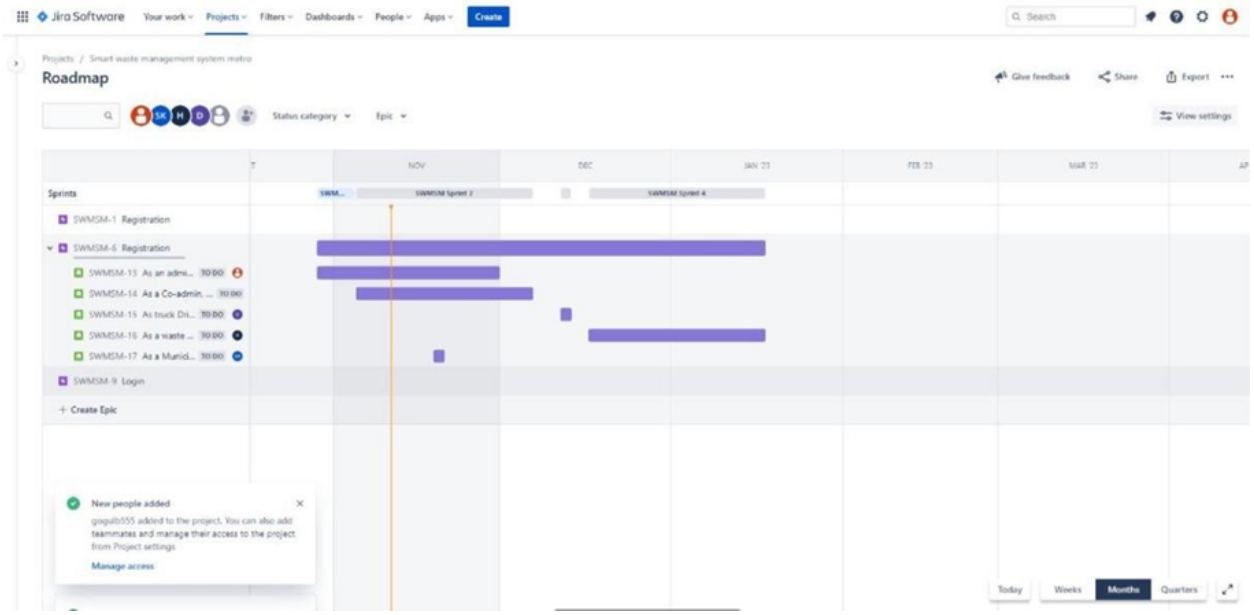
6.2 Sprint Delivery Schedule:

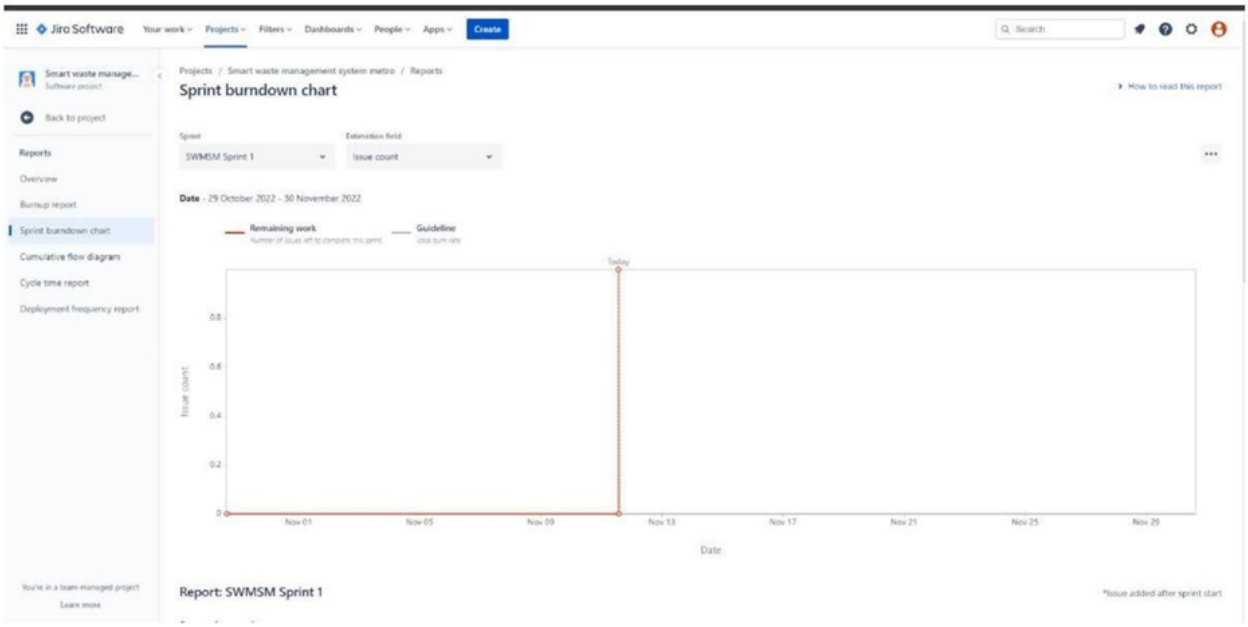
Sprint	Total Story Points	Duration	Sprint Start Date	Sprint End Date (Planned)	Story Points Completed (as on Planned End Date)	Sprint Release Date (Actual)
Sprint-1	20	6 Days	24 Oct 2022	29 Oct 2022	20	29 Oct 2022
Sprint-2	20	6 Days	31 Oct 2022	05 Nov 2022	20	05 Nov 2022
Sprint-3	20	6 Days	07 Nov 2022	12 Nov 2022	20	12 Nov 2022
Sprint-4	20	6 Days	14 Nov 2022	19 Nov 2022	20	19 Nov 2022

6.3 Reports from JIRA

BURNDOWN CHART







7. CODING & SOLUTIONING

7.1 Feature 1: **Tracking Bin Level**

CODE:

```
#include <SoftwareSerial.h>
#include <String.h>

#define proxout 3
#define trigPin 5
#define echoPin 6
#define binid 5098
#define maxbinlevel 25

float duration, distance=50;
String str;
SoftwareSerial SIM900(9,10); //rx,tx

void setup(){
  Serial.begin(9600);
  SIM900.begin(9600);  /* Define baud rate for software serial communication */
  pinMode(proxout,INPUT);
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);

str="AT+HTTPPARA=\"URL\",\"sajeevkrishna10.pythonanywhere.com/statupdate?binid="+Strin
g(binid)+"&binstatus=";
```

```
  initgsm();
}

void loop(){
  if (digitalRead(proxout)== LOW){
    //switch on the ultrasonic sensor to scare them away
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10000);
    digitalWrite(trigPin, LOW);
  }
  else if (digitalRead(proxout)== HIGH){
    digitalWrite(trigPin, LOW);
    delayMicroseconds(2);
    digitalWrite(trigPin, HIGH);
    delayMicroseconds(10);
    digitalWrite(trigPin, LOW);

    // Measure the response from the HC-SR04 Echo Pin

    duration = pulseIn(echoPin, HIGH);

    // Determine distance from duration
    // Use 343 metres per second as speed of sound

    distance = (duration/2)*0.0343;

    Serial.print("Distance = ");
    Serial.print(distance);
    Serial.println(" cm");

    distance=(distance/maxbinlevel)*100;
    //calculate percentage

    Serial.print("level = ");
    Serial.print(distance);
    Serial.println(" %");

    delay(500);
    }

  str=str+String(distance)+"\"";
  Serial.println(str);
  Serial.println(str);
  SIM900.println(str);
```

```
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+HTTPACTION=0");
  SIM900.println("AT+HTTPACTION=0");
  delay(10000);
  ShowSerialData();
  delay(10000);
  Serial.println("AT+HTTPREAD");
  SIM900.println("AT+HTTPREAD");
  delay(8000);
  ShowSerialData();
  delay(8000);
  Serial.println("AT+HTTPTERM");
  SIM900.println("AT+HTTPTERM");
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+SAPBR=0,1");
  SIM900.println("AT+SAPBR=0,1");
  delay(5000);
  ShowSerialData();
  delay(5000);

}
void initgsm(){
  Serial.println("AT");
  SIM900.println("AT");
  delay(5000);
  ShowSerialData();
  delay(5000);

  Serial.println("AT+SAPBR=3,1,\"CONTYPE\",\"GPRS\"");
  SIM900.println("AT+SAPBR=3,1,\"CONTYPE\",\"GPRS\"");
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+SAPBR=3,1,\"APN\",\"www\"");
  SIM900.println("AT+SAPBR=3,1,\"APN\",\"www\"");
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+SAPBR=1,1");
  SIM900.println("AT+SAPBR=1,1");
```

```
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+SAPBR=2,1");
  SIM900.println("AT+SAPBR=2,1");
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+HTTPINIT");
  SIM900.println("AT+HTTPINIT");
  delay(5000);
  ShowSerialData();
  delay(5000);
  Serial.println("AT+HTTPPARA=\"CID\",1");
  SIM900.println("AT+HTTPPARA=\"CID\",1");
  delay(5000);
  ShowSerialData();
  delay(5000);
}
void ShowSerialData()
{
  while(SIM900.available()!=0)  /* If data is available on serial port */
  Serial.write(char (SIM900.read())); /* Print character received on to the serial monitor */
}
```

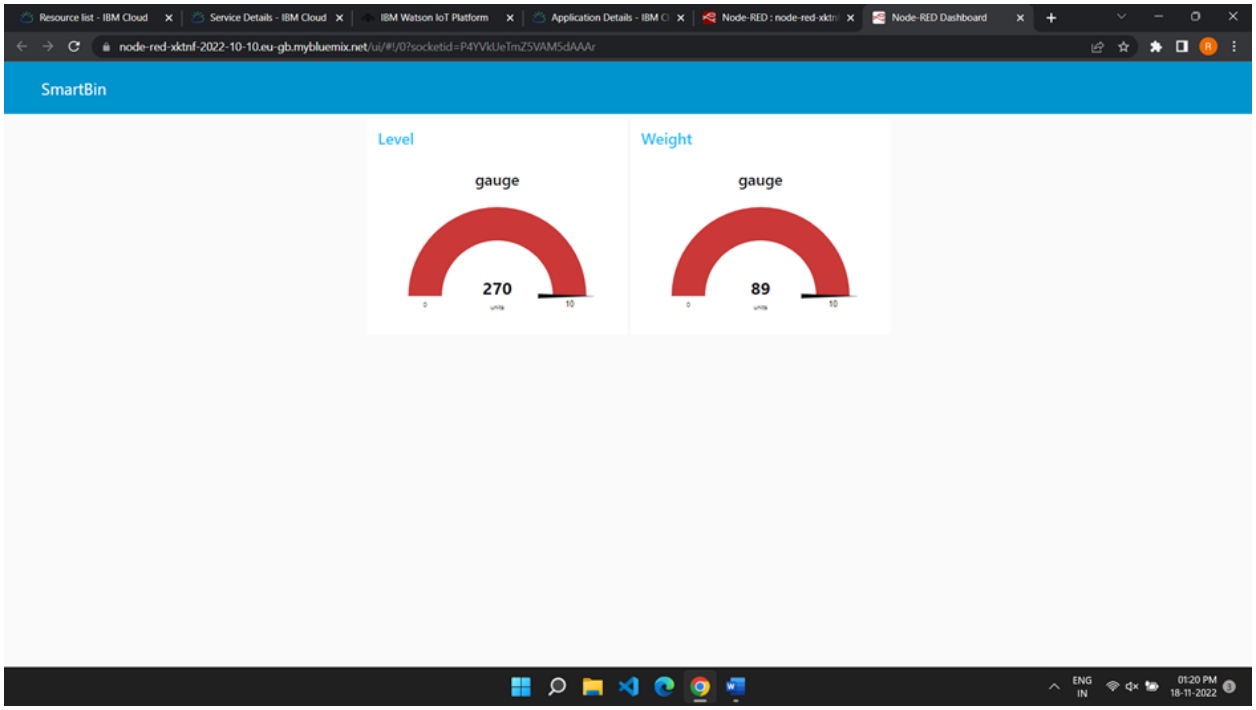
7.2 Feature 2: Displaying details in Web & Mobile Application

CODE:

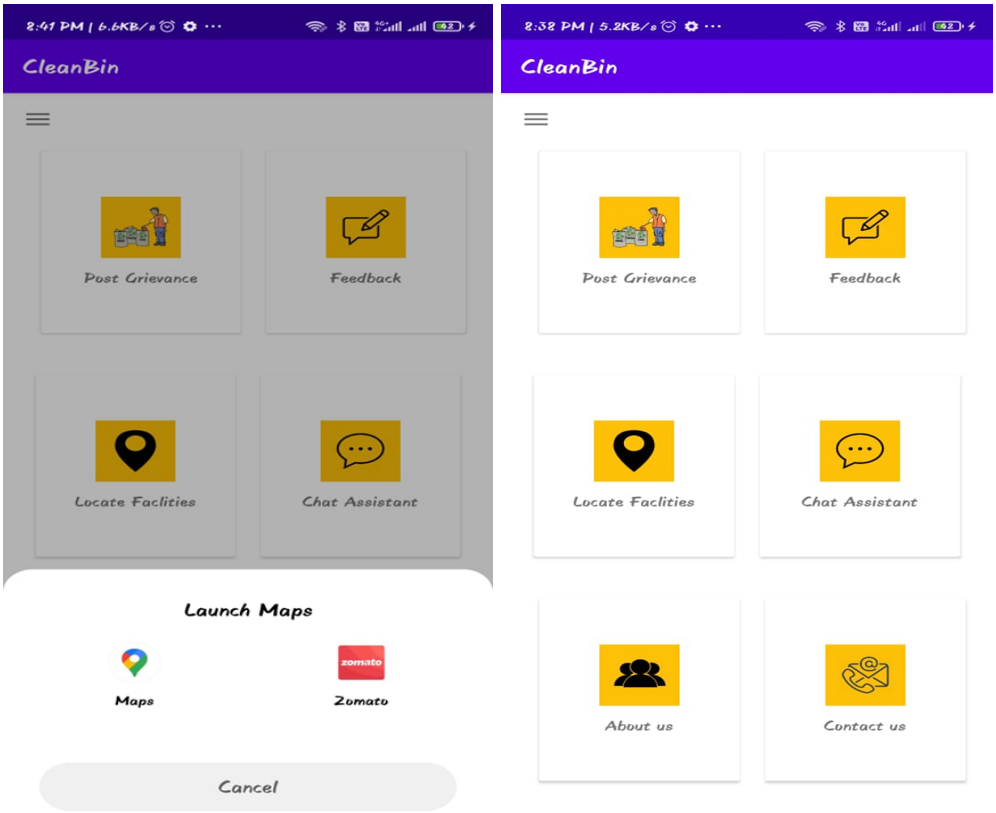
```
<!DOCTYPE html>
  <html>
  <!-- manifest="dashboard.appcache"> -->
  <head>
    <meta charset="utf-8">
    <meta name="viewport" content="width=device-width,initial-scale=1">
    <meta name="apple-mobile-web-app-capable" content="yes">
    <meta name="apple-mobile-web-app-status-bar-style" content="black-translucent">
    <meta name="apple-mobile-web-app-title" content="Node-RED">
    <meta name="mobile-web-app-capable" content="yes">
    <meta name="theme-color" content="#097479">
    <meta http-equiv="X-UA-Compatible" content="IE=edge">
    <link rel="manifest" href="manifest.json" crossorigin="use-credentials">
    <link rel="icon" sizes="192x192" href="icon192x192.png">
    <link rel="shortcut icon" type="image/png" href="icon64x64.png">
    <link rel="apple-touch-icon" href="icon120x120.png">
    <link rel="stylesheet" href="css/app.min.css">
```

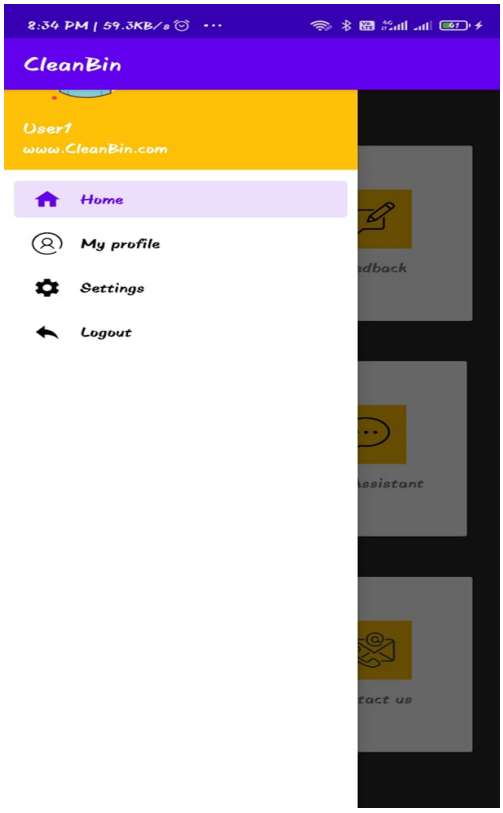
```
    <link rel="stylesheet/less" href="css/app.min.less">
    <title></title>
  </head>
  <body id="nr-dashboard" ng-app="ui" ng-controller="MainController as main" ng-cloak
layout="column" style="background: {{main.backgroundColor}}" class="nr-dashboard-theme"
ng-swipe-right="onSwipeRight();" ng-swipe-left="onSwipeLeft();"
ng-attr-ng-swipe-disable-mouse="{{main.allowSwipe !== 'mouse' ? '' : undefined}}">
    <md-content ng-if="main.loaded" ng-include="'partials/main.html'" layout="column"
flex></md-content>
    <div ng-if="!main.loaded && !main.nothing" ng-include="'loading.html'"
class="node-red-ui--loading"></div>
    <div ng-if="main.nothing" class="node-red-ui--notabs">
      <table>
        <tr>
          <td>
            <center><img src="icon120x120.png"></center>
          </td>
        </tr>
        <tr>
          <td>
            <center>
              <h2>Welcome to the Node-RED Dashboard</h2>
            </center>
          </td>
        </tr>
        <tr>
          <td>
            <center>GAUGE</center>
          </td>

          <td>
            <center>GAUGE</center>
          </td>
        </tr>
      </table>
    </div>
    <script src="socket.io/socket.io.js"></script> <script src="js/app.min.js"></script> <script
src="i18n.js"></script>
  </body>
</html>
```

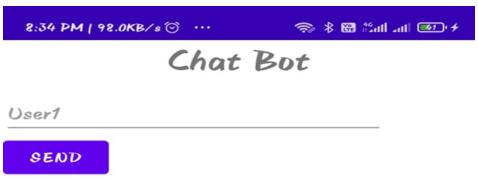
Footer

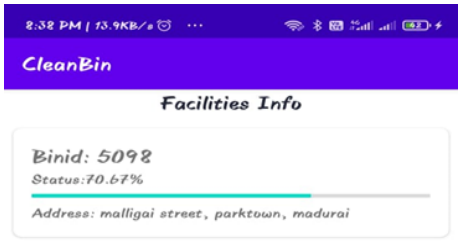


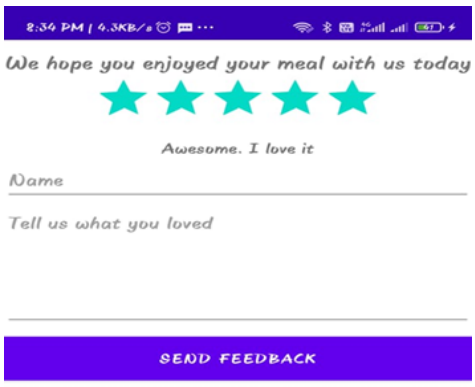
MOBILE APPLICATION:

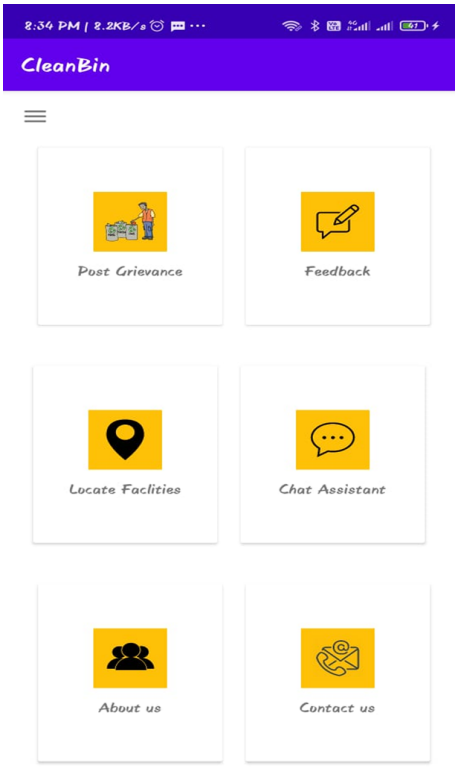



8:34 PM | 59.3KB/s
CleanBin
User1
www.CleanBin.com
Home
My profile
Settings
Logout


8:34 PM | 98.0KB/s
Chat Bot
User1
SEND

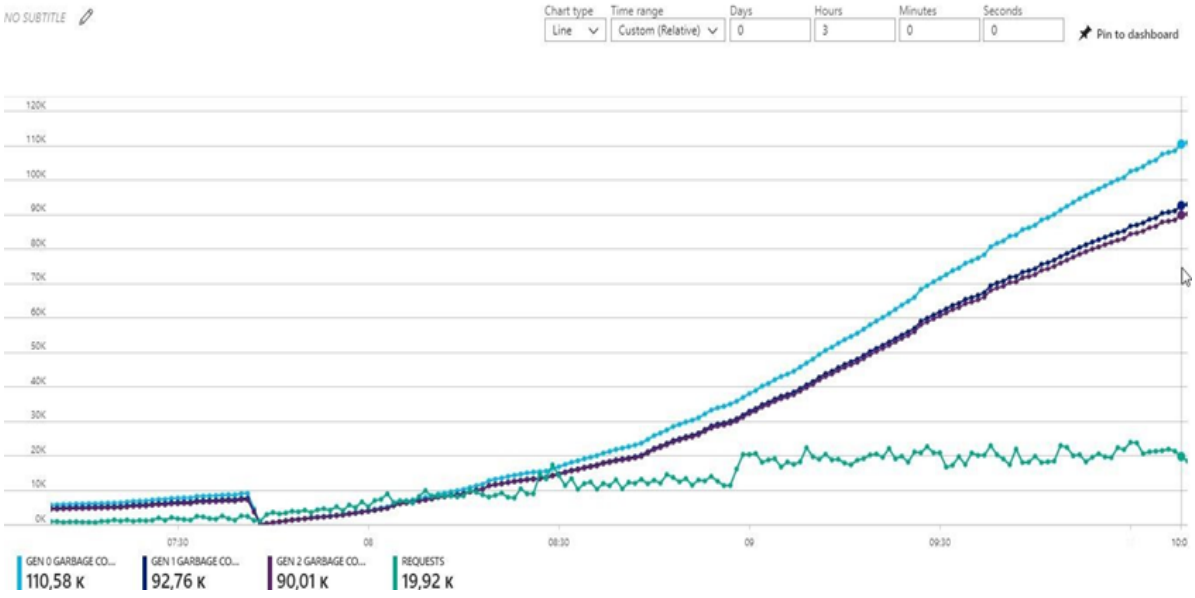

8:38 PM | 13.9KB/s
CleanBin
Facilities Info
Binid: 5098
Status:70.67%
Address: malligai street, parktown, madurai

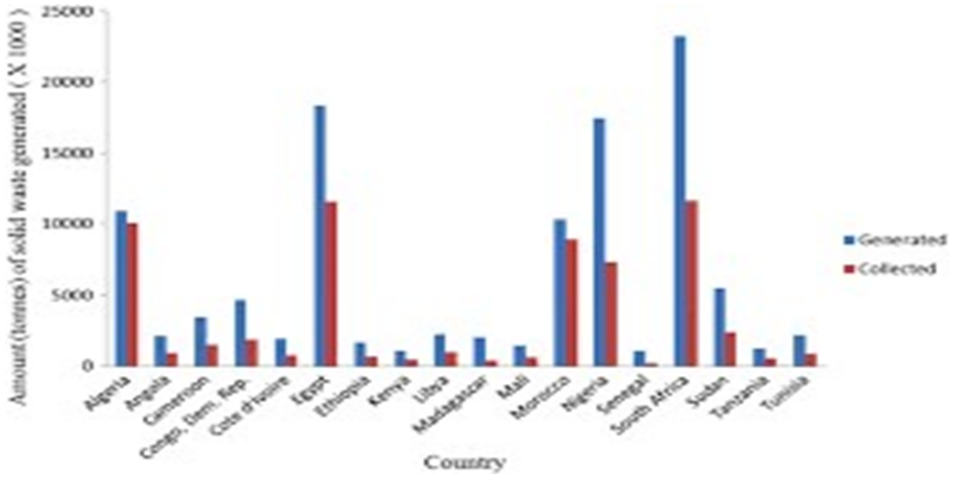

8:34 PM | 4.3KB/s
We hope you enjoyed your meal with us today
Awesome. I love it
Name
Tell us what you loved
SEND FEEDBACK



8. RESULTS & TESTING

8.1 Performance Test:





9. ADVANTAGES & DISADVANTAGES:

Advantages:

- People can easily identify the location of the dustbins
- People can also check for the level of the bin that is being filled.
- Monkeys and other animals would not disturb as we have placed appropriate sensors.
- Reduction in Collection Cost
- No Missed Pickups
- Reduced Overflows
- Waste Generation Analysis
- CO2 Emission Reduction

Disadvantages:

- Accuracy may be differ due to some unavoidable conditions
- Not at all the features that are impact the production be taken
- System requires a greater number of waste bins for separate waste collection as per population in the city.
- This results in high initial cost due to expensive smart dustbins compared to other methods.
- Sensor nodes used in the dustbins have limited memory size.

10. CONCLUSION

A Smart Waste Management system that is more effective than the one in use now is achievable by using sensors to monitor the filling of bins. Our conception of a "smart waste management system" focuses on monitoring waste management, offering intelligent technology for waste systems, eliminating human intervention, minimizing human time and effort, and producing a healthy and trash- free environment. The suggested approach can be implemented in smart cities where residents have busy

schedules that provide little time for garbage management. If desired, the bins might be put into place in a metropolis where a sizable container would be able to hold enough solid trash for a single unit. The price might be high.

- This system is very much useful for the corporation department. It helps make the cities smarter and manage waste in an effective manner.
- As the problem of knowing the waste level in real time, the problem of overflowing dustbins is solved.
- And domestic and stray animals are prevented from coming near the dustbin thereby avoiding the spread of disease.
- Moreover, the mobile application also serves as a platform for citizens to report their issues.
- This system enables the municipal corporation to work more efficiently.

11. FUTURE SCOPE

There are several future works and improvements for the proposed system, including the following:

- To implement in real time and review how the product actually works in real time and also to add google directions API to improve direction facility in the mobile application.

- Change the system of user authentication and atomic lock of bins, which would aid in protecting the bin from damage or theft.
- The concept of green points would encourage the involvement of residents or end users, making the idea successful and aiding in the achievement of collaborative waste management efforts, thus fulfilling the idea of Swachh Bharath.
- Having case study or data analytics on the type and time waste is collected on different days or seasons, making bin filling predictable and removing the reliance on electronic components, and fixing the coordinates.
- Improving the Server's and Android's graphical interfaces.

12. APPENDIX

Source Code:
https://github.com/IBM-EPBL/IBM-Project-31791-1660205120/tree/main/SOURCE%20CODE

Github link:
https://github.com/IBM-EPBL/IBM-Project-31791-1660205120

Project demo link:
https://drive.google.com/drive/folders/1A4yoBxAmybwof6tIOTgrXxzKkLzlc1Vg?usp=share_link